

## CLAIMS

### WHAT IS CLAIMED IS:

1                   1.     A battery charger that is modular and reconfigurable and  
2 provides flexible, multi-port rapid charging, and selectable output capabilities,  
3 the battery charger comprising:

4                         base modules providing DC power charging voltage, each  
5 base module of the base modules including a power converter and providing  
6 output voltage for charging a battery, wherein each base module includes an  
7 intermediate high frequency transformer; and

8                         a master controller that interfaces with the base modules to  
9 regulate power delivered by each base module.

1                   2.     The battery charger of claim 1, wherein the base modules  
2 further comprise an inverter and a rectifier.

1                   3.     The battery charger of claim 2, wherein the base modules  
2 further comprise a slave microprocessor controller with which the master  
3 controller communicates in a call and response communication format.

1                   4.     The battery charger of claim 3, wherein the slave  
2 microprocessor controller sets current and voltage commands based on  
3 communications from the master controller.

1                   5.     The battery charger of claim 3, wherein the master controller  
2 auto-configures current and power rating of the charger based on the number of  
3 base modules connected and detected.

1                   6.     The battery charger of claim 5, wherein the auto-  
2 configuration operation comprises an enumeration procedure that determines  
3 how many base modules are connected.

1                   7.     The batter charger of claim 5, wherein the inverter comprises  
2 a single switch.

1                   8.     The battery charger of claim 5, wherein the inverter  
2 comprises four switches.

1                   9.     The battery charger of claim 2, wherein the inverter  
2 comprises a full bridge.

1                   10.    The battery charger of claim 2, wherein the inverter  
2 comprises two switches.

1                   11.    The battery charger of claim 2, wherein the inverter  
2 comprises a half bridge.

1                   12.    The battery charger of claim 2, wherein the inverter  
2 comprises a half bridge.

1                   13.    The battery charger of claim 2, wherein the rectifier  
2 comprises a full wave rectifier.

1                   14.    The battery charger of claim 2, wherein the rectifier  
2 comprises a push-pull rectifier.

1                   15.    The battery charger of claim 1, further comprising a current  
2 mode controller for each of the base modules, wherein the current mode  
3 controller regulates output current based on a command set from the master  
4 controller.

1                   16.    The battery charger of claim 15, further comprising a voltage  
2 mode controller for each of the base modules, wherein the voltage mode  
3 controller regulates output voltage based on a command set from the master  
4 controller.

1                   17. The battery charger of claim 16, further comprising a droop  
2 sharing control for each of the base modules that ensures current sharing  
3 between base modules.

1                   18. A battery charging system comprising:  
2                   a modular power stage configured to receive an alternating  
3 current (AC) input and provide a direct current (DC) output for charging a  
4 battery, the modular power stage comprising:  
5                   an inverter coupled to a rectifier circuit, the inverter  
6 having as its input an input voltage, the rectifier circuit having as its output a  
7 battery charging voltage;  
8                   an intermediate high frequency transformer  
9 intermediate the inverter and the rectifier to convert alternating current (AC)  
10 voltage from the inverter to a lower voltage input to the rectifier;  
11                   a current mode controller coupled to the output of the  
12 rectifier circuit and provides a current control signal for the modular power  
13 stage;  
14                   a voltage mode controller coupled to the output of the  
15 rectifier circuit and provides a voltage control signal for the modular power  
16 stage; and  
17                   a droop sharing control that ensures current sharing  
18 between a plurality of modular power stages under constant voltage operation;  
19 and  
20                   a system controller that interfaces with the modular  
21 power stage and regulates power delivered by the modular power stages.

1                   19. The battery charging system of claim 18, wherein the  
2 switching circuit is controlled by a pulse width modulation (PWM) controller.

1                   20. The battery charging system of claim 18 further comprising  
2 relays coupled to the output of the plurality of modular power stages to control  
3 output thereof.

1                   21. The battery charging system of claim 18 wherein the system  
2 controller configures the plurality of modular power stages depending on battery  
3 charging needs.

1                   22. A modular and reconfigurable battery charger having rapid  
2 charging capabilities, the battery charger comprising:

3                   (a) means for receiving an AC voltage and providing an output  
4 voltage to charge a battery, wherein the means for receiving an AC voltage and  
5 providing an output voltage comprises a means for transforming a high  
6 frequency AC voltage to a lower voltage;

7                   (b) means for controlling output current based on a current  
8 command set;

9                   (c) means for controlling output voltage based on a voltage  
10 command set; and

11                  (d) means for controlling multiple means for providing an output  
12 voltage to charge a battery, wherein the multiple means for providing an output  
13 voltage to charge a battery are coupled in parallel.

1                   23. The battery charger of claim 22, further comprising means  
2 for controlling droop based on the output current to ensure current sharing  
3 between a plurality of modular power stages under constant voltage operation.

1                   24. The battery charger of claim 23, wherein current sharing  
2 includes utilizing a highest current technique.

1                   25. The battery charger of claim 23, wherein current sharing  
2 includes utilizing an average current technique.

1                   26. The battery charger of claim 22, further comprising relays  
2 coupled to the multiple means for providing an output current to charge a  
3 battery.

1                   27. A method for charging batteries using a plurality of modular  
2 battery chargers, the method comprising:

3                   receiving an indication that a first battery is connected to a first  
4 base module;

5                   if one or more batteries other than the first battery are connected  
6 to one or more base modules other than the first base module, performing the  
7 operations of:

8                   (a) closing output relays of all base modules with batteries  
9 connected;

10                  (b) identifying a base module with lowest discharged  
11 battery;

12                  (c) closing the parallel relay of the base module with the  
13 lowest discharged battery;

14                  (d) closing parallel relays of all base modules with no  
15 batteries connected;

16                  (e) configuring base modules with closed parallel relays  
17 for parallel operation;

18                  (f) setting up remaining base modules as stand alone  
19 chargers; and

20                  (g) loading charging parameters into the base modules;

21 if no other batteries other than the first battery are detected as  
22 connected to one or more base modules, performing the operations of:

23 (a) closing an output relay of a base module with lowest  
24 discharged battery;

25 (b) closing all parallel relays to the base modules;

26 (c) configuring the base modules for parallel operation;

27 and

28 (d) loading charging operations into the base modules;

29 starting a charging cycle.

1 28. The method of claim 27, wherein if a change in battery  
2 connections is detected before a charge cycle is completed, saving a last charge  
3 state and stopping charging.